Electronics Radiation Characterization (ERC) Project
under the
NASA Electronic Parts and Packaging Program (NEPP)

Presentation at the RHET Meeting

November 14, 2001

Ken LaBel
ERC Project Manager
ken.label@gsfc.nasa.gov
301-286-9936

Allan Johnston
ERC Deputy Project Manager
allan.h.johnston@jpl.nasa.gov
818-354-6425

Outline

ERC Thrust Areas

Review Key Accomplishments in FY01

- Evaluation of advanced technology (COTS) devices
- Hardness assurance and testing
- Optoelectronics
- Advanced Sensors
- Evaluation of emerging technology devices (*the future*)
- Anomalies in fielded space systems

Summary

Main ERC Thrust Areas

Advanced Technology Devices (*the present: COTS*)

Emerging Technology Devices (*the future*)

Optoelectronics: photonic devices and data links

Advanced Sensors

MEMS

Hardness Assurance and Radiation Testing

Radiation Effects at Extreme Temperature

Anomalies and Issues in Fielded Space Systems

Web Sites and Data Dissemination

Radiation Characterization of COTS

Objectives

- Provide flight designers' a wider database of COTS devices with assessment data
- Determine radiation failure levels for COTS devices
- Develop technology selection guidelines
- Provide analyses of novel failure modes

Deliverables

- Database on radiation effects in COTS devices for flight project selection (yearly)
- Test qualification methodologies as applicable to specific emerging COTS technologies

Highlights of Recent Results for COTS

- Total Dose Tests of Low-Power Linear Circuits
- Single-Event Transients in Comparators
- Tests of Advanced ADCs
- Evaluation of High-Density Memories
  - DRAMs
    - Stuck bits
    - Complex failure modes
  - Flash memories
- SEGR in RF Power MOSFETs

Testing and Hardness Assurance

Linear Device Testing

- Low dropout regulators
- Linear devices with wide operating voltage ranges
- Displacement damage from protons
  - Characterization methods
  - Synergistic effects between total dose and displacement damage
- Enhanced damage at low dose rate

Latchup

- Testing methods: importance of ion range
- Catastrophic damage

Failed Metallization in an Analog-to-Digital Converter after Latchup

Failed metallization

Guidelines and Tools for Optoelectronics

Near-term guidelines under development

- Optocoupler qualification test and hardness assurance (draft end FY01)
- Proton testing of fiber links (draft end FY01)

Long-term guideline under development

- Charge-coupled devices (CCDs) lessons learned and NASA approach to radiation qualification and assessment

SEE-Induced Predictive Model for Transients in F.O. Links (draft end FY01)

Engineering Flight Data Anomaly Analysis

Reviewed flight performance data from SeaSTAR solid state recorder

- (SSR), XTE SSR, MPTB AS1773 Fiber Optic Data Bus (FODB)
- Includes long-term tracking of performance variance from Solar Min to Solar Max as well as solar particle events (SPEs)

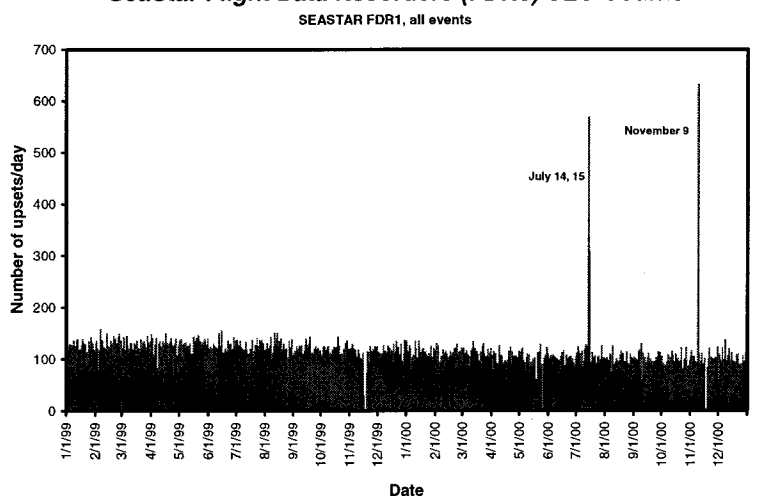
Completed TERRA anomaly analysis

Continued evaluation of new optocoupler failures on TOPEX. Failure levels are in close agreement to 1997 predictions by JPL radiation group.

Completed Cassini power module PM139 SET correlation to in-flight anomalies in solid-state power switch modules

Engineering Flight Data Anomaly Analysis

SeaStar Flight Data Recorders (FDRs) SEU Counts



Emerging SiGe IC Technology

Single-Event Upset Tests Completed on Si-Ge Prescalar
- Fabricated with IBM 5HP Heterojunction bipolar technology
- Circuits contain a few hundred transistors
- Tests at frequencies up to 3 GHz

Threshold LET < 1 MeV-cm^2/mg
- Complex dependence on operating frequency
- Also sensitive to upset from protons

Ferroelectric and Novel Memory Technologies

Total Dose Tests of Ramtron Devices
- Cobalt-60 and proton tests
- Failure levels 10-20 krad (limited by underlying CMOS technology)

SEU Tests
- Sensitive to latchup
- Different foundry will be used in the future

No Fundamental Radiation Issues for Ferroelectric Memory Elements

Advanced Sensors

Heavy ion single particle tests performed on APS devices in collaboration with DTRA/SAIC and Photobit Technologies

Paper presented at IEEE NSREC July 2001 concerning charge transfer efficiency measurement techniques in visible CCDs

Guideline in development for insertion of new sensor technologies in future NASA space systems

Radiation Effects Websites

Provide Radiation Data, Analyses and Reports

Specific Databases
- RADATA (JPL)
- RADHOME (GSFC)

http://erc.gsfc.nasa.gov
http://radhome.gsfc.nasa.gov
http://radnet.jpl.nasa.gov

Highlights: Technology Evaluations

Key Technology Evaluations

- Non-proprietary SEE evaluation of unhardened SiGe IC technology
- Transient evaluation of advanced pixel sensor (APS) devices
- Proton evaluation of GaAs radio frequency (RF) MEMS switch
- Evaluations of various wavelength LEDs and laser diodes
- Investigation of back-thinning application to SEU testing
- Thin oxide breakdown from heavy ions
- Single event latchup (SEL) investigation on reliability effects

Other technology evaluations

- Advanced DRAMs: stuck bits and complex failure modes
- Advanced analog-to-digital converter (ADCs)
- DC-DC converters
- CMOS/SOS pre-scalar device
- Ferroelectric RAMs

Summary

ERC Provides Critical Information for NASA Space Applications Relating to Radiation Effects

Key Activities

- Radiation testing of a wide range of devices
- Technology evaluations
  - Highly scaled devices
  - Emerging COTS and advanced technology devices
  - Radiation testing and hardness assurance
  - Optoelectronics

Information Available in Reports, Technical Papers and Databases